Popular scientific summary of master thesis in Civil Engineering

Application of ERT for Quality Assurance in Jet Grouting Columns

A development of an alternative quality control

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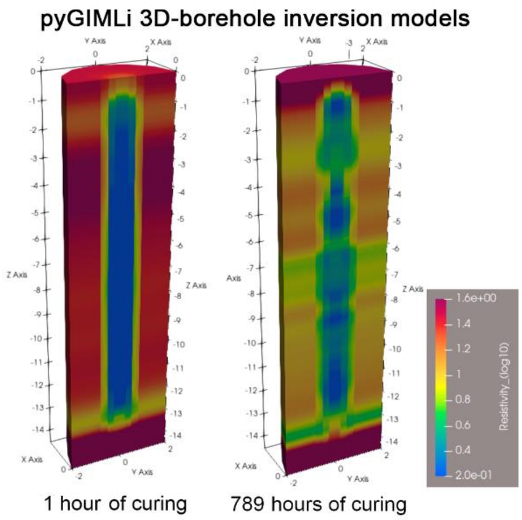
With the increased urbanization major cities are facing, additional structures must be constructed on the ground surface which need sufficient soil strength to be built upon. But with more land used for constructing on, the risk of variable soil conditions increases, and sufficient soil strength becomes more uncertain. One solution to this problem is jet grouting, which is a versatile soil improvement method that radially injects cement slurry in a pre-drilled borehole to erode and mix in-situ soil that forms a stabilized underground column. The most important aspects of achieving desirable properties of the column are the homogeneity of the grout mixture and the diameter of the column, but this can be difficult to inspect without a quality control that intrudes on the surrounding soil. Therefore, can a less intrusive quality control be used for quality assuring jet grouting columns specifically within Electrical Resistivity Tomography (ERT) -practice, and is it comparable with existing quality controls?

The underground soil can consist of different layers which inherit certain resistances towards eroding and mixing. This can affect how far the injected grout will penetrate radially into each soil layer, causing the diameter of the column to be varied. Discontinuous column diameter can severely compromise the intended column properties. By routinely performing quality controls on jet grout columns, the column diameter and the homogeneity of the grout mixture can be estimated. However, existing quality controls differ in accuracy and credibility which is why this thesis' purpose was to investigate if an alternative quality control could be developed using ERT.

ERT is a geophysical measuring method that measures the resistivity distribution of the underground by injecting current through electrodes in contact with a material. By applying this method into jet grout columns, the expectation of finding a resistivity contrast between the treated volume and the surrounding soil as well as the resistivity distribution of the treated soil would determine the homogeneity and geometry of the column.

In-field measurements were performed on a test column at a construction site which comprised of inserting a composed cable into the centreline of a freshly produced column. The composed cable consisted of a multi-electrode cable with a spacing of 0.5 meters and 4 temperature sensors mounted on the electrode cable to ensure both ERT- and temperature measurements were performed simultaneously at different depths throughout the curing process. An ABEM Terrameter LS2 instrument was used, measuring in dipole-dipole and multigradient configurations.

The inversion procedure was carried out in two different computer software: pyGIMLi and Res2DInv. A borehole geometry was implemented to the measured data in both software for a better interpretation of the resistivity distribution. This was made due to the original geometry was based on traditional ERT-measuring, where the electrodes would assume to be on the ground surface. 3D-borehole inversions were made in pyGIMLi while cross-borehole inversions were executed in Res2DInv.



The results indicated that a resistivity contrast between the treated volume and the surrounding soil was found for both inversion software which decreased with curing time. The pyGIMLi-models seemed to better correlate with the measured data compared to Res2DInv, mainly due to Res2DInv assuming a 2D-geometry. Many outliers and errors were also found in the data, that could be explained by corrosion taking place on the electrodes' surfaces. Thereby, a different measuring setup or equipment suited for jet grout conditions could have provided better data quality.

Furthermore, this quality control was not verified and was unable to be compared with existing quality controls. Many existing quality controls are performed when curing of the column is finished, while the ERT-method can give results directly after column installation. That is why the ERT-method has the potential to be a time-effective quality control with refinement in inversion modelling and routine application.